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INFLUENCE OF TWO VARIABLES UPON ACQUIRED REINFORCING POWER
WHEN THE SECONDARY REINFORCER IS USED TO ESTABLISH A NEW RESPONSE
IN A NEW STIMULUS SITUATION

by

REBECCA G. MILES

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Influence of Two Variables Upon Acquired Reinforcing Power When the Secondary Reinforcer is Used to Establish a New Response in a New Stimulus Situation," submitted by Rebecca G. Miles in partial fulfillment of the requirements for the degree of Master of Arts.

Abstract

This experiment was designed to determine the relationship between secondary reinforcing power, as indicated by a new-learning measure, and extinction strength of an instrumental approach-to-reward response elicited by S^R . To facilitate comparison between conditioned response strength and reinforcing power of S^R , two variables presumed to have differential effects upon extinction of the approach response were manipulated. The test procedure also was designed to determine whether a secondary reinforcer would strengthen a new response when that response occurred in a stimulus situation which had never been associated with primary reward.

An approach-to-reward response sequence was conditioned to distinctive stimulus aspects of a straight-runway training apparatus. For half of the S s in each of three response-condition groups, the approach response conditioned to S^N was followed by primary reward on 60 per cent of the training trials; the remaining S s received 100 per cent primary reward during training. There were seven albino rats in each of the six groups called for by the design. Each S experienced 120 trials in the training apparatus, followed by 70 test trials. At the beginning of testing, a distinctive test box was attached to the runway; a lever-pressing response in this box caused a door to open and allowed S to proceed through the designated section of the runway and approach the empty food cup.

Partial primary reward of the response to S^N had the customary effect upon acquisition strength of the runway responses, in that partial facilitation occurred in the later stages of training. The difference in terminal acquisition strength between partially-

and continuously-rewarded Ss, however, was not significant in any of the three response-condition groups. Extinction responding was stronger and more durable after partial than after continuous reward. The response-condition variable had the predicted effect upon extinction performance of continuously-rewarded Ss: (1) a more effortful response sequence was significantly less resistant to extinction than a less effortful response to S^r , and (2) performance was stronger when the approach response was conditioned and extinguished under more rather than less similar stimulus conditions. The latter effect also occurred during extinction after partial reward, but the influence of a difference in effortfulness was contrary to predictions. Strength of the secondarily reinforced lever-pressing response was significantly greater after partial than after continuous reward of the response to S^N during training, and the response-condition variable had the predicted effect upon lever-pressing performance of all Ss. Despite the similar effects of the treatment variables and similar day-to-day changes in strengths of both responses, there was no significant correlation between lever-pressing speed and extinction strength of the response elicited by S^r . There apparently is no adequate theoretical explanation for this result.

The demonstrated capacity of a secondary reinforcer to strengthen a new response in a new stimulus situation was the unique contribution of this experiment. When the new lever-pressing response in a distinctive test box was followed by instrumental behavior conditioned to stimuli that had preceded primary reward during training, lever pressing increased in strength and performance was maintained over 70 test trials.

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Table of Contents

	Page
Abstract	iii
Acknowledgments	v
Table of Contents	vi
List of Tables and Figures	vii
Introduction	1
Method	
Subjects	11
Apparatus	11
Experimental Design	15
Procedure	15
Results	
Training	21
Testing	23
Discussion	34
Summary	41
Bibliography	44

List of Tables and Figures

Table		Page
1.	Experimental treatment groups	16
2.	Summary table: analyses of variance of approach-response data	24
3.	Summary table: analysis of variance of lever-press data	29

Figure

1.	Scale drawing of the apparatus	12
2.	Approach speeds as a function of training days . . .	22
3.	Extinction scores as a function of test days	25
4.	Speed of lever pressing as a function of test days .	31

Introduction

Many investigations have shown that a neutral stimulus (S^N) which is repeatedly paired with primary reward (S^R) will acquire reinforcing properties. Such a stimulus is then referred to as a secondary reinforcer (S^r); its reinforcing properties are demonstrated in a test situation where primary reinforcement does not occur and where the occurrence of S^r is contingent upon a particular instrumental response. The reinforcing power of the previously neutral stimulus is measured in terms of the strength of the response that produces S^r .

It would be universally agreed that all methods of establishing a secondary reinforcer involve conditioning of some response to S^N . Various studies have demonstrated that several of the same variables that determine strength of conditioning also determine strength of an S^r : Stronger S^r 's have been produced by more frequent pairing of S^N and S^R (Bersh, 1951, Exp. 2), larger amounts of primary reinforcement (D'Amato, 1955), and an interstimulus interval closely approximating the optimum CS-UCS interval in classical conditioning (Bersh, 1951, Exp. 1). There is, however, a difference of opinion as to which basic type of conditioning is primarily responsible for the development of secondary reinforcing properties. In all successful training procedures, the occurrence of S^N immediately preceding and/or accompanying S^R provides a situation in which S^N could acquire control over either classically-conditioned responses or instrumental approach-to-reward behavior.

Several learning theorists (Hull, 1952; Mowrer, 1960; Seward, 1956) propose that classical conditioning of a fractional anticipatory

goal response to S^N accounts for the establishment and effectiveness of secondary reinforcers. When S^N (CS) is paired with S^R (UCS), fractional components of the goal response (UCR) become conditioned to S^N . During training the S^N is thus established as a conditioned elicitor of a fractional anticipatory goal response (r_g). The occurrence of r_g produces a distinctive stimulus, s_g , and this hypothetical r_g - s_g mechanism in some way carries the power to strengthen instrumental behavior. According to this interpretation, all secondary reinforcement training procedures would be sufficient (in that they all provide pairing of S^N and S^R), but those methods whereby S^N and S^R are both presented by the experimenter would be considered superior. These methods most closely resemble the usual classical conditioning procedure--the experimenter controls the occurrence of S^N (CS) and S^R (UCS) and therefore has control over length of the interstimulus interval. Although secondary reinforcers have been established by this method (Bersh, 1951, Exp. 1; Estes, 1949; Fox & King, 1961), subsequent tests of S^R strength have revealed only weak and transitory secondary reinforcement effects. After reviewing several secondary reinforcement experiments, Wyckoff (1959) concluded: "It is probably no accident that this procedure has generally been abandoned, usually in favor of a paradigm in which \underline{S} is first conditioned to make some (instrumental) response by the use of primary reinforcement paired with the initially neutral stimulus." (p. 69).

According to the instrumental-conditioning hypothesis (Dinsmoor, 1952; Schoenfeld, Antonitis, & Bersh, 1950; Zimmerman, 1959), the mere pairing of S^N and S^R is not sufficient; the S^N acquires rein-

forcing properties only when it is followed by an instrumental response which is reinforced by S^R presentation. In all successful secondary reinforcement training methods, some approach-to-reward response invariably follows (or coincides with) S^N and immediately precedes S^R . In Skinner box procedures, onset of a distinct stimulus (e.g., flash of light, sound of buzzer) precedes approach to S^R ; in runway experiments, an approach response in the presence of distinctive goal-box stimulation procures S^R . Failure to establish an S^r in the Schoenfeld et al. (1950) investigation (in which S^N presentation was controlled by the experimenter) was attributed to the fact that onset of S^N slightly followed instigation of eating behavior and therefore could not have become a discriminative cue for approaching the food tray. The authors concluded that the S^N must be established as a discriminative stimulus if it is to function as a secondary reinforcer. Subsequent Skinner box experimenters have presented S^N before delivery of S^R and have taken pains to avoid presenting S^N while S is hovering over the reward-delivery aperture (i.e., to insure the occurrence of some primarily rewarded approach response following S^N).

Assuming the necessity for conditioning of an instrumental response to S^N during establishment of an S^r , a question would still exist as to whether secondary reinforcing power depends upon occurrence of this response in the test situation. Results of a study by Keehn (1962) indicate that strengthening effects of S^r upon new learning are dependent upon occurrence of the response previously conditioned to S^N . Keehn first trained rat Ss in a 24-in.-long double-compartment box to establish S^N (buzz plus opening

of a partition) as a cue for leaving the restraining compartment and entering the other compartment to obtain primary (water) reinforcement. Secondary reinforcement affects were measured by inserting a bar into the restraining compartment and arranging conditions so that bar pressing was rewarded by S^r . Results of this investigation showed that new learning was strengthened only when the previously-learned instrumental (approach-to-reward) response was permitted during testing--when each bar press produced the buzz, but Ss were either not allowed to enter the water compartment or required to enter by making a new approach response, there was no evidence of learning. For those Ss permitted to make the previously-learned approach response, response strength (latencies from partition opening to touching water tube) remained approximately the same throughout testing. Keehn's results show that S^r is not effective when the response conditioned to it is physically prevented; they do not indicate whether there is a functional relationship between response strength (when the response is permitted) and reinforcing power of S^r .

Estes (1949) suggests, on the basis of observational evidence, that a new response is strengthened by secondary reward only so long as the presentation of S^r continues to elicit the conditioned approach-to-reward response. Since primary reinforcement is never given during the test of S^r strength, initiation of testing marks the beginning of extinction for the response conditioned to S^r . If secondary reinforcement is dependent upon elicitation of this response, then prolonged extinction responding would increase the durability of S^r effects. Furthermore, it is possible that reinforcing

power is positively related to strength of the response elicited by S^r ; in this case, strength of the response reinforced by S^r and extinction strength of the response elicited by S^r should vary concomitantly throughout testing. In order to determine the relationship between secondary reinforcing power (i.e., strength of the response that produces S^r) and extinction strength of the approach-to-reward response, an experiment must provide for the occurrence of a clearly defined and independently measured response following S^N (training) and S^r (testing). The present experiment was designed so that such a comparison could be made. To increase the precision of statistical comparisons and to extend the generality of the findings, two variables (percentage of primary reward during training, and response condition during training and testing) presumed to have differential effects upon extinction of the response to S^N were manipulated.

An approach-to-reward response sequence in a straight runway (17-in. alley, 9-in. goal box) was conditioned to distinctive stimulus aspects of the training apparatus (i.e., black color, smooth texture) and to an auditory stimulus (2-sec. buzz) which began as S entered the goal box. In the test phase of the experiment, a new response (lever pressing) in a distinctive test box (grey color, rough texture) allowed S to enter the training apparatus; this response "produced" S^r (i.e., stimuli which had preceded S^N during training) and permitted S to make the approach-to-reward response leading to the now-empty food cup. Reinforcing power was measured in terms of lever-press speeds, which were compared with extinction scores indicating strength of the response to S^r .

The approach-to-reward response was conditioned to neutral stimulation which occurred on every trial and was followed by S^R either 100 per cent (continuously-rewarded \underline{S} s) or 60 per cent (partially-rewarded \underline{S} s) of the time. A secondary reinforcement study by Zimmerman (1959) indicates that partial reward during runway training may produce an extremely durable secondary reinforcer when reward value is indicated by strength of a new response. Zimmerman first established S^N (buzz in combination with lifting of start box door) as a cue for running to a goal box containing food reinforcement; as a test of secondary reinforcing power, a lever was inserted into the start box and conditions were arranged so that a lever press produced S^R and permitted \underline{S} to run to the empty goal box. After partial primary reward of S^N (30 continuously reinforced trials, followed by 60 trials with a gradually decreasing percentage of reward), partial secondary reinforcement (gradually decreasing percentages until one response in 20 was rewarded) of the new lever pressing response resulted in stable and prolonged (10 to 14 90-min. sessions) responding. Strength of the running response conditioned to S^R , measured in terms of starting times, continued at about the same level throughout testing. It should be noted, however, that the results of this experiment could have been influenced by two conditions other than partial reward of the running response during training: (1) In contrast with the usual procedure of using the same percentage of reward throughout training, Zimmerman instigated a partial reward schedule only after the instrumental response had been established under continuous reinforcement; and (2) Zimmerman used a partial secondary reward schedule during

testing. In any case, since all Ss were partially reinforced during training, no comparisons can be made as to the relative effects of continuous and partial primary reward of the response to S^N .

Several investigators, however, have shown that resistance to extinction of runway responses is greater after partial reward than after continuous reinforcement. In a study by Freides (1957), a comparison of equivalent groups showed significantly faster extinction running speed in both alley and goal box after partial reward; Theios and Polson (1962) found that partial reward of runway behavior produced stronger extinction responding in terms of both running speed in alley and goal box and number of trials to reach an extinction criterion; and Weinstock (1958) reported that rate of decrement in running speed was less and extinction asymptote was higher as a function of decreasing percentages of reward during acquisition. We would predict, therefore, that partial reward of approach responses conditioned to S^N in the present experiment will produce stronger extinction responding throughout secondary reinforcement test sessions. If there is a positive relationship between reinforcing power and strength of the response elicited by S^R , then the reinforcing value of S^R should be greater for partially-rewarded than for continuously-rewarded Ss.

There were three response-condition groups (each divided into partial- and continuous-reward subgroups): Two of the response-condition groups learned two successive responses--hurdle-jumping in the alley, and running in the goal box. One of these groups (Condition I) was permitted to make both alley and goal-box responses during testing--i.e., lever pressing preceded and "released" the

entire instrumental sequence; a lever-pressing response by Ss in the second group (Condition II) gave access directly to the goal box--i.e., lever pressing immediately preceded the final segment of the training response sequence. Members of the third group (Condition III) were placed at the entrance to the goal box during training and were tested under the goal-box-only condition. The predicted difference between test performance of continuously-rewarded and partially-rewarded Ss should hold for all three response conditions--despite variation in length of the response sequence and in similarity between training and testing conditions, extinction running speeds of the partially-rewarded Ss should be faster and their response to S^r should be more durable.

Two tentative predictions may be made concerning relative extinction strength of the response to S^r under the three response conditions. Conditions I and III differ only in regard to length of the approach-to-reward response, with the longer response (Condition I) being clearly more effortful. From Hull's (1952) theory of extinction, which hypothesizes that magnitude of reactive inhibition is an increasing function of effortfulness of a response, it follows that a more effortful response will be less resistant to extinction. Capehart, Viney, and Hulicka (1958) found a decrease in number of extinction responses as a function of effort (5-, 40-, 70-gm. loading on a Skinner box lever) required to make the response. The inhibition theory of extinction and results of the Capehart et al. experiment suggest that Ss trained and extinguished on the longer, more effortful response sequence (Condition I) will show less resistance to extinction than Ss (Condition III) trained

and extinguished on the shorter, less effortful response. If secondary reinforcing power is dependent upon extinction strength of the conditioned approach response, there should be a corresponding difference in the reinforcing value of S^r .

Subjects under Conditions II and III were tested with the goal-box-only condition, i.e., lever pressing "produced" S^r (distinctive goal-box stimuli) and permitted S to make the conditioned goal-box running response. These two conditions differed only in that training and testing situations are more similar for Condition III than for Condition II. Under Condition II, where alley and goal-box responses were learned during training, running in the goal box was conditioned to a stimulus pattern which undoubtedly included (in addition to the external goal-box stimulation experienced by both groups) traces of proprioceptive stimuli produced by the hurdle-jumping response in the alley. Since the alley response was not permitted during testing, these response-produced stimuli were eliminated from the customary goal-box stimulus pattern; as a result, amount of stimulus generalization from training to testing should be less for Condition II than for Condition III (Hull, 1952), and Ss under Condition II should show a larger decrement in strength of the conditioned goal-box running response. Results of an investigation by Fink and Patton (1953) showed a progressive decrease in response strength as more and more elements were eliminated from the stimulus pattern to which the response had been conditioned. Extinction strength of the goal-box running response should therefore be less under Condition II (tested in an altered stimulus situation) than under Condition III (trained and tested under similar

stimulus conditions); if there is a positive relationship between secondary reinforcing power and resistance to extinction of the response elicited by S^r , the effectiveness of S^r should be greater under Condition III than under Condition II.

Use of a factorial design will make it possible to simultaneously determine differential effects of the two experimental variables upon strength of the approach-to-reward response conditioned to S^r . Similarly, it will be possible to determine effects of the various treatments upon acquisition strength of the response reinforced by S^r . Subsequent statistical analyses will then enable us to discover and describe the hypothesized functional relationship between secondary reinforcing power and strength of the instrumental response elicited by S^r . At the same time, demonstration of the effectiveness of a secondary reinforcer under the unique test conditions of the present study will increase the generality of the secondary reinforcement concept.

Many investigations have shown that stimuli which precede primary reward during training will subsequently exert a reinforcing effect upon behavior occurring in the same situation. No previous study, however, has measured the effectiveness of a secondary reinforcer when the response which produces S^r occurs under stimulus conditions differing from those experienced in the training phase of the experiment. The present study was planned in part to determine whether a secondary reinforcer (distinctive stimulus aspects of the training apparatus) will strengthen a new response when that response occurs in a new stimulus situation--a test box designed so that visual and tactual cues would be distinctively different from stimuli experienced during training.

Method

Subjects

The Ss were 42 experimentally naive male albino rats, approximately 50 days old at the beginning of the experiment. Taming and adaptation to a 23-hr. food deprivation schedule began seven days before pretraining. Each day, Ss were placed on a table top in groups of six and allowed to explore for 10 min., during which the experimenter picked up and handled each S for 1 min. The animals were fed 9 gm. of Purina Dog Chow once a day, immediately after testing; water was continuously available in the home cage. The Ss were housed and tested at the University of Alberta Animal Laboratory.

Apparatus

The four separate apparatus components, as shown in Figure 1 (p. 12), were constructed of 1/4-in. plywood; all parts of the apparatus were 2-1/2 in. wide and 6 in. high (inside dimensions), and were covered with hinged lids of clear plastic. The entry box was 5 in. long--there was a hinged entrance door at one end and a 3-in. high by 2-1/2-in. wide exit (no door) at the bottom of the opposite end; component B was a 17-in. alley with two 3-in.-high plastic hurdles located 2 in. and 8-1/2 in. from the entrance; and the goal box, component C, was 9 in. long. A 1/8-in. thick by 1-in. high wood barrier extended the width of the goal box, 1 in. from the far end, forming a 1- by 2-1/2-in. food cup; this barrier served to conceal the presence or absence of reward until S traversed the goal box and "nosed" the food cup. The walls and floor of the entry box, the alley, and the goal box were painted black; side walls were

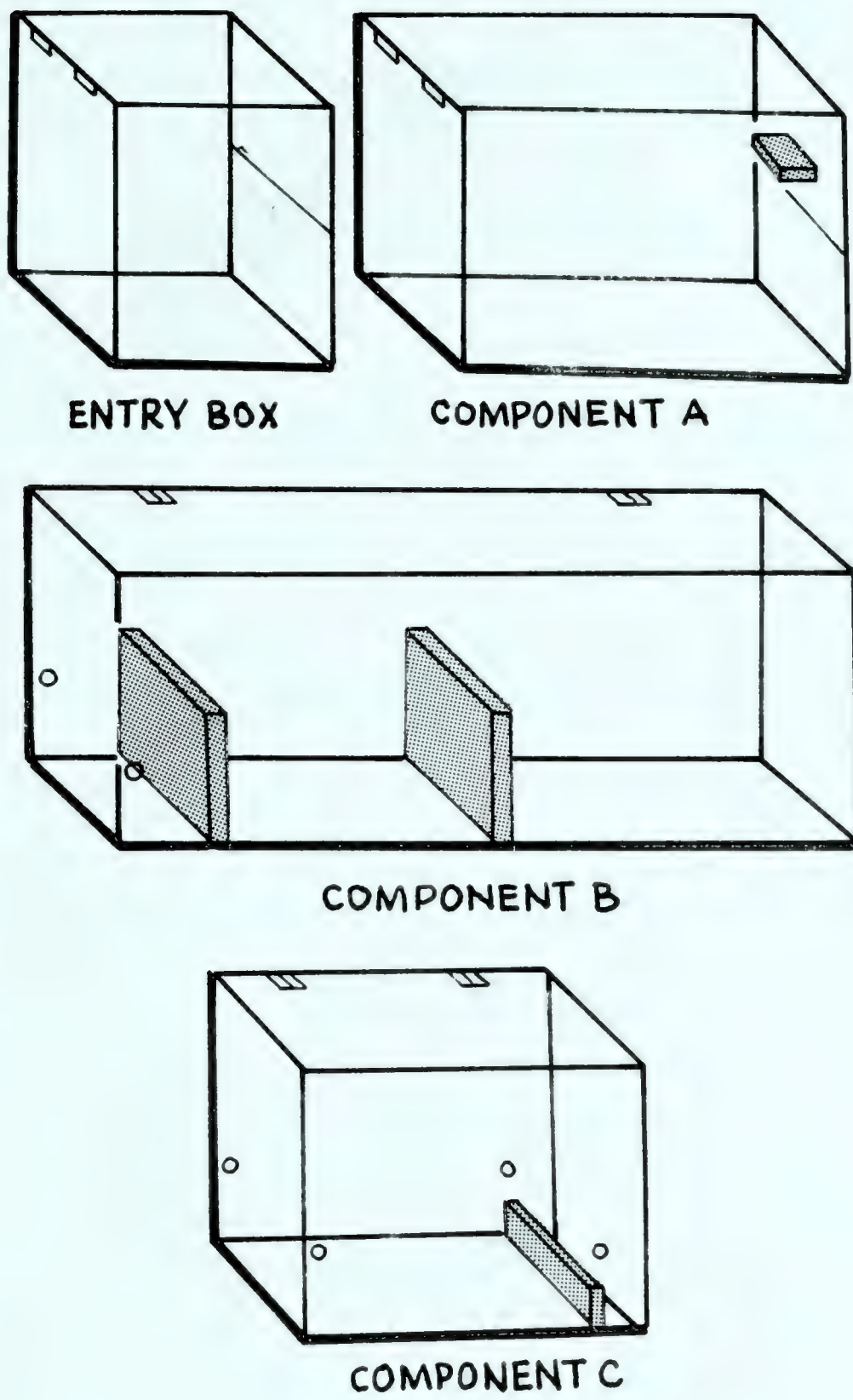


Figure 1. Scale drawing of the apparatus (1/4 in. = 1 in.).

lined with thin sheets of clear plastic. A black metal guillotine door at the entrance to the goal box could be lowered to prevent retracing. Component A (the lever-equipped test box) was 9 in. long; it was painted grey and the side walls and floor were covered with hardware cloth. Thus, there was a distinct color and texture difference between component A and the rest of the apparatus. At one end of the box was a hinged entrance door; the lever, located on the opposite wall of the compartment, was 1-1/4 in. long and projected 3/4 in. into the box, 4 in. above the floor. A 3-in. high by 2-1/2-in. wide grey metal exit door was located immediately below the lever.

Apparatus components could be fitted together in the following sequences to fulfill training and testing requirements: Training: either entry box-component B-component C, or entry box-component C. Testing: either component A-component B-component C, or component A-component C. Introduction into the entry box during training placed S directly in front of the open exit; no response was required in the entry box, and S could immediately enter the next apparatus component. At the beginning of testing, the entry box was removed from the apparatus and component A substituted in its place; a lever press by S activated a relay which caused the sliding metal exit door to lower, revealing an opening identical to the exit from the entry box and permitting S to enter the next apparatus component.

Response times in components B and C were obtained by means of Standard Electric .01-sec. timers connected to photoelectric units placed at the entrance to B, at the entrance to C, and 1 in. before the end of C (immediately above the barrier that formed one

side of the food cup). Light beams passed through infrared filters (rendering them invisible to S) and crossed the runway at a height of 1-3/4 in. Interruption of successive light beams (a) started one timer, (b) stopped the first timer and started a second timer, and (c) stopped the second timer. Activation of the photocell at the entrance to component C also caused a muffled 6-v. doorbell buzzer to sound for 2 sec. Thus, clocks were activated in such a way as to record time taken to traverse the 17-in. alley and time of approach to the food cup (8 in.) in the goal box. When component B was not used, response time in C was obtained by means of the appropriate photocells and timer.

In order to obtain testing response measures, a microswitch and timer arrangement was connected so that closing the entrance door to component A activated a microswitch, starting a timer which stopped when S pressed the lever. This latency measure represented strength of the new, secondarily reinforced lever-pressing response. Other response measures during testing were obtained by means of the photocell and timer arrangements described above; the buzzer always sounded when S entered component C.

A separate apparatus was employed during pretraining to acquaint S with stimuli produced by the lowering of a door similar to the exit door of component A. Since door-opening was not experienced during regular training, prior adaptation to these novel stimuli (a loud "click" and a rapid movement as the door lowered) was considered desirable. This pretraining apparatus was 21 in. long by 2-1/2 in. wide by 4 in. high; it was divided into two compartments by a black metal sliding door which could be manually lowered by

the experimenter.

A round wire cage was used to transport S from the housing area to the test room and to detain S during between-trial waiting periods. The cage was 7-1/4 in. high, 8-1/2 in. in diameter, and had a plastic lid.

Experimental Design

As illustrated in Table 1 (p. 16), the treatment groups comprise a 2 x 3 factorial design. There are two levels (100% and 60%) of the primary reward variable. Response condition is varied in three ways: I--trained on alley (B) and goal-box (C) responses, tested with the lever-pressing response in (A) preceding the BC response sequence; II--trained on alley (B) and goal-box (C) responses, tested with the lever-pressing response in (A) preceding the C response; and III--trained on the goal-box (C) response, tested with the lever-pressing response in (A) preceding the C response. Seven Ss were randomly assigned to each of the six groups called for by the design.

Procedure

Pretraining (6 days). Procedures used on the first two days of pretraining were designed to acquaint Ss with the training apparatus. On Day 1, pairs of Ss were given 5 min. to explore the entire apparatus. On Day 2, individual Ss were placed in the goal box for a 2-min. period, during which each S obtained 10 97-mg. Noyes Rat Food pellets from the food cup,

The next three days were spend in adapting Ss to stimuli associated with opening of a door similar to the one to be used during testing. On Day 3, Ss in pairs were allowed to explore the pretraining apparatus for 5 min. with the door open. On Day 4

Table 1

Experimental Treatment Groups

Percentage of Primary Reward	Response Condition		
	I	II	III
	BC-ABC	BC-AC	C-AC
100% (c)	Group I-c	Group II-c	Group III-c
60% (p)	Group I-p	Group II-p	Group III-p

and 5, Ss were individually placed in the pretraining apparatus for 5 min. Food pellets were scattered on the floor of the runway. A period began with the sliding door closed; throughout the period the experimenter lowered the door whenever S approached it. All Ss received at least 16 door-opening experiences.

On Day 6, each S was given five trials according to the following procedure: (1) S put in entry box and traversed that portion of the runway to be used for its particular group during training; (2) as S entered goal box, buzzer sounded for 2 sec.; (3) goal box door closed and 10 sec. were allowed for obtaining and eating one 97-mg. food pellet; (4) S removed from goal box to a between-trial detention cage where it remained for 30 sec.

Training (to establish neutral stimulation as a secondary reinforcer). Each S received 10 trials per day for 12 days. The S^N (visual and tactual apparatus cues, and a 2-sec. buzz which began as S entered the goal box) occurred on every trial. For the three 100% subgroups, every occurrence of S^N was immediately followed by S^R (one 97-mg. food pellet). Subjects in the three 60% subgroups received S^R on six of the ten daily trials; the other 40% of S^N presentations were not followed by primary reward. Daily sequences of rewarded (R) and nonrewarded (N) trials were based upon an estimate as to the probability of runs of different lengths when there are two sequentially independent events--one (R) occurring 60% of the time; the other (N), 40% of the time--and when the length of the sequence is ten. Maximum run length for both R and N was two, there were 12 possible sequences, and the first and last trial of each sequence was rewarded. The sequence to be used for the first session

was randomly chosen from the 12 possibilities, the second choice was made from the remaining 11 alternatives, etc. All Ss in the 60% subgroups received the same sequence on the same day.

Animals trained under Conditions I and II learned an instrumental response sequence comprising a hurdle-jumping response in the alley and a running response in the goal box; this sequence occurred in the presence of S^N and was followed by S^R on either 100% (Groups I-c and II-c) or 60% (Groups I-p and II-p) of the trials. Thus, a relatively long and effortful response sequence was learned. An individual training trial for these four groups consisted of the following events: (1) S put in entry box and traversed alley; (2) as S entered goal box, buzzer sounded for 2 sec.; (3) door closed, confining S in goal box for 10 sec.; (4) S removed from goal box and placed in the detention cage for a 30-sec. between-trial interval.

Animals trained under Condition III were required to learn only the running response in the goal box; this instrumental response occurred in the presence of S^N and was primarily reinforced on either 100% (Group III-c) or 60% (Group III-p) of the trials. Thus, a relatively short, less effortful response was learned. Each training trial proceeded as follows: (1) S placed in entry box so that its head entered the goal box and activated the 2-sec. buzzer; (2) door closed, confining S in goal box for 10 sec.; (3) S removed from goal box and placed in detention cage for 30-sec. between-trial interval.

Testing (to determine S^R strength). Following the 120 training trials, all primary reward was discontinued and each S received

10 test trials per day for 7 days. The lever-equipped test box was substituted for the entry box, and the apparatus was arranged so that a lever press was immediately followed by lowering of the door between the test box and the next apparatus component--either B (for Groups I-c and I-p) or C (for Groups II-c, II-p, III-c, and III-p).

An individual trial began when S was placed in the test box. A lever press by Ss tested under Condition I allowed S to proceed through the alley and enter the empty goal box. As in testing, S remained in the goal box for 10 sec. and was then removed to the detention cage for a 30-sec. between-trial interval. A lever press by Ss tested under Conditions II and III gave access directly to the empty goal box where S was confined for 10 sec., then removed and detained in the waiting cage for 30 sec.

Measures of performance. The following performance measures were obtained for various groups during training and testing: (1) Running time in the alley (17 in.), (2) running time in the goal box (time to traverse the 8 in. between entrance and food-cup barrier), and (3) lever-press latency (interval between closing of test box entrance door and the first lever press). Each raw time score was converted to a speed measure by a reciprocal transformation. Response speeds in the alley and goal box were taken as a measure of acquisition strength of the approach-to-reward response conditioned to S^N . In order to express extinction strength of this response during testing in comparable terms for the various groups, the following steps were taken: (1) Mean individual speeds on Training Day 12 were calculated for that portion of the runway

to be used during testing, i.e., mean alley-plus-goal box speed for each S in Groups I-c and I-p, mean goal box speeds for Ss in the other four groups. (2) Extinction scores for each S were expressed as percentages of the mean response speed of that S on Training Day 12. The reinforcing power of S^r during testing was measured in terms of lever-press speeds.

Results

Training

Mean daily alley and goal box speeds are plotted in Figure 2 (p. 22). Examination of the curves illustrating alley performance of Groups I and II reveals that partially-rewarded Ss ran more slowly than continuously-rewarded Ss in the early trials. The curves then converge and cross, and partially-rewarded Ss ran faster in the later stages of training. This pattern of comparative acquisition responding under continuous and partial reward is similar to the results of several runway experiments (Capaldi et al., 1962; Goodrich, 1959; Weinstock, 1954, 1958), and it has been interpreted in terms of the "frustration" hypotheses of Amsel (1958) and of Spence (1960).

The curves illustrating acquisition of the approach-to-reward response in the goal box (Figure 2) do not present a consistent picture of comparative partial- and continuous-reward effects. Goal box speed was slower in Group I-p than in Group I-c on early acquisition trials, whereas partially-rewarded Ss in Groups II and III ran faster throughout training. Although all other experiments have found that partial facilitation either did not occur at all in the goal box (Freides, 1957; Goodrich, 1959, Exp. 1) or occurred later as performance was measured closer to the goal region of the runway (Capaldi et al., 1962, Exp. 2; Goodrich, 1959, Exp. 2), there would seem to be no theoretical interpretation to adequately explain why partial reward effects should vary in this way. A "frustration" theory (Amsel, 1958; Spence, 1960) apparently would predict earlier and greater partial facilitation in the goal box than in the alley. Such an effect is revealed in the present experiment when the alley and goal box

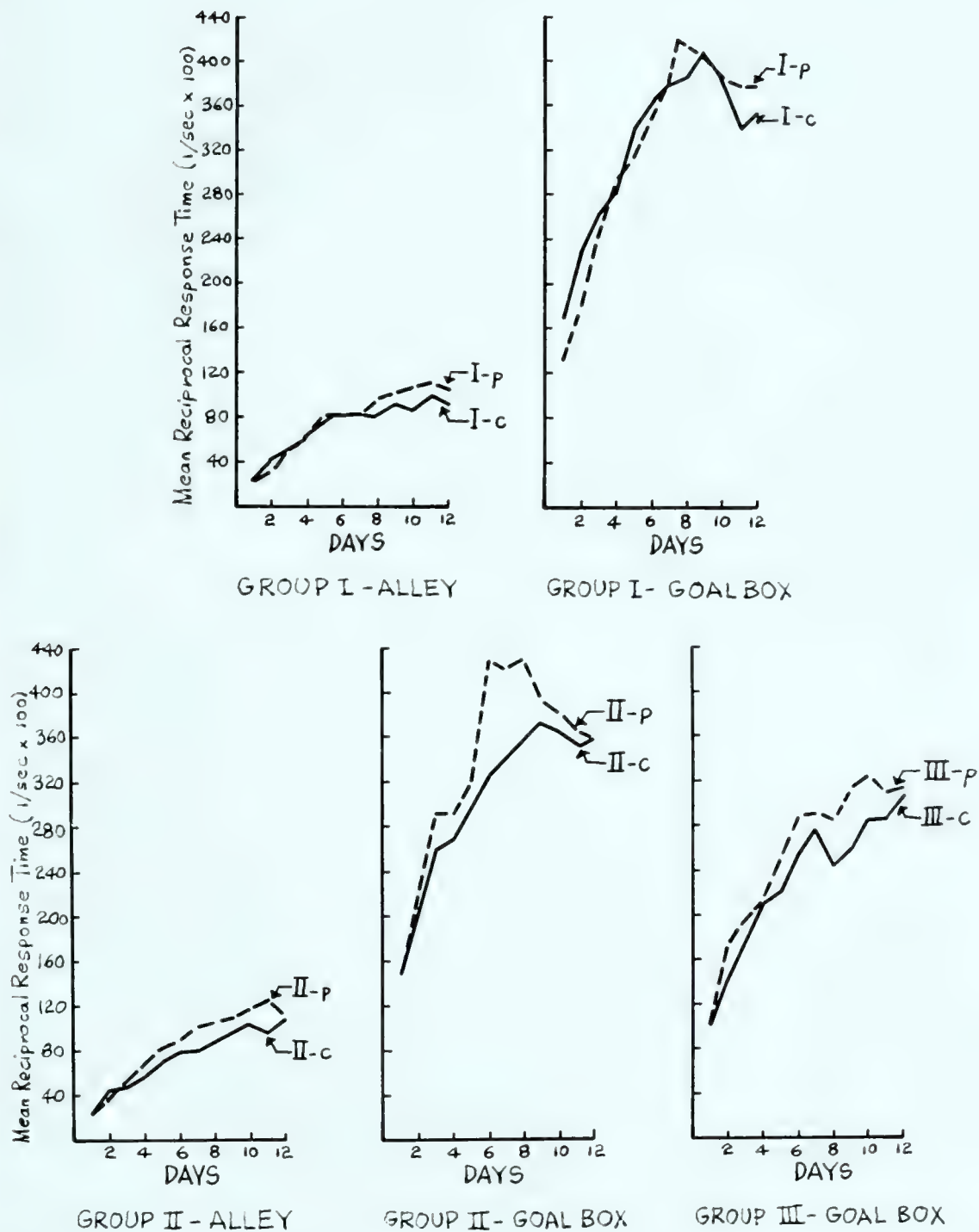


Figure 2. Approach speeds as a function of training days. The two curves illustrate performances of continuous- and partial-reward subgroups; each point represents mean performance of 7 Ss on 10 daily trials.

responses of Group II are compared, and when acquisition under the goal-box-only condition (Group III) is compared with alley performance of the other two groups.

Mean response speeds on Training Day 12 were calculated for that portion of the runway to be used for each group during testing. Results of t-tests revealed that there was no significant difference in terminal acquisition strength between partially-rewarded and continuously-rewarded Ss in any of the three response-condition groups.

Testing

Extinction strength of the conditioned approach-to-reward response. Approach-response data (extinction scores) were subjected to a trend analysis (Edwards, 1960) in which there were two treatment factors (percentage of primary reward, and response condition) and a dependent variable consisting of mean response speeds on the seven test days. A significant interaction between reward percentage and response condition ($F = 3.56$, $df = 2/36$, $p < .05$) suggested that it would be advisable to separately analyze the effect of each treatment factor at each level of the other factor (Table 2, p. 24).

Mean overall extinction performance was stronger after partial than after continuous reward in all response-condition groups, although the difference between means is significant only in Group I. The significant A x C interactions indicate that the trend of the daily means during extinction after partial reward is different from the trend after continuous reward at all three levels of the response-condition factor. Figure 3 (p. 25) illustrates these trends under each of the three response conditions. After approximately equal approach speeds on the first test day, continuously-rewarded Ss in all

Table 2

Summary Table: Analyses of Variance of Approach-Response Data

Source of Variation	Sum of Squares	d.f.	Mean Square	F	p
<u>Response Condition I</u>					
A: Reward percentage	2.783788	1	2.783788	62.98	.01
Error (a)	.530411	12	.044201		
C: Days	1.384064	6	.230677	17.03	.01
A x C: Rew. per. x days	.968400	6	.161400	11.92	.01
Error (b)	.975307	72	.013546		
<u>Response Condition II</u>					
A: Reward percentage	.243303	1	.243303	2.45	
Error (a)	1.188442	12	.099037		
C: Days	.431422	6	.071904	5.21	.01
A x C: Rew. per. x days	.258313	6	.043052	3.12	.01
Error (b)	.994242	72	.013809		
<u>Response Condition III</u>					
A: Reward percentage	.604058	1	.604058	3.49	
Error (a)	2.079538	12	.173295		
C: Days	1.188617	6	.198103	5.25	.01
A x C: Rew. per. x days	1.064437	6	.177406	4.70	.01
Error (b)	2.717396	72	.037742		
<u>Continuous Reward (100%)</u>					
B: Response condition	.687539	2	.343769	3.20	.05
Error (a)	1.933700	18	.107428		
C: Days	1.675281	6	.279214	9.91	.01
B x C: Resp. cond. x days	1.393269	12	.116106	4.12	.01
Error (b)	3.143503	108	.028181		
<u>Partial Reward (60%)</u>					
B: Response condition	1.158872	2	.579436	14.77	.01
Error (a)	.705817	18	.039212		
C: Days	1.400141	6	.233357	8.99	.01
B x C: Resp. cond. x days	.824781	12	.068732	2.65	.01
Error (b)	2.804095	108	.025964		

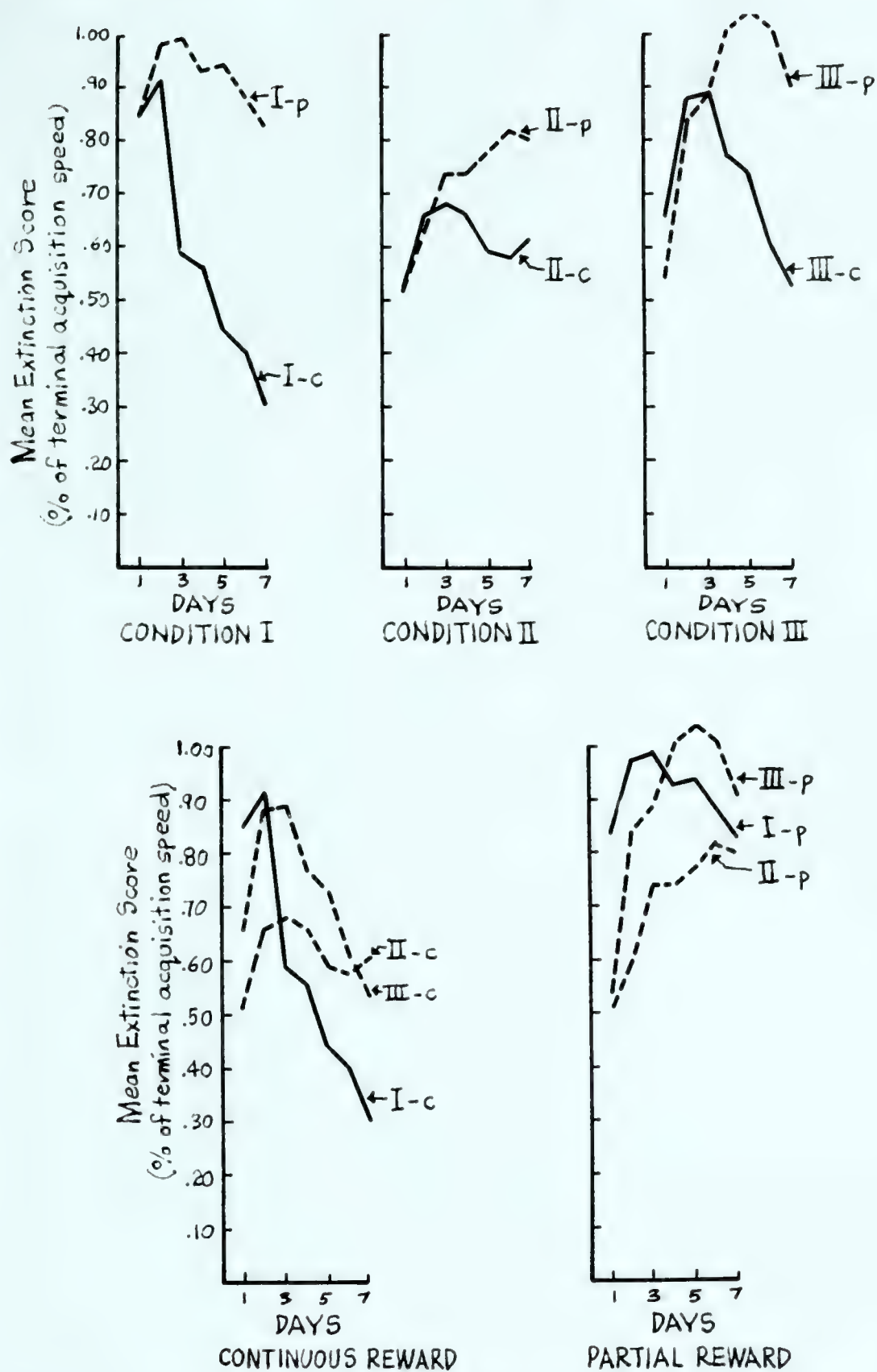


Figure 3. Extinction scores as a function of test days. The two curves for each response-condition group illustrate performances of continuous- and partial-reward subgroups; the three curves for each reward-percentage condition illustrate performances of the three response-condition groups. Each point represents mean performance of 7 Ss on 10 daily trials.

groups showed weaker maximum performance and an earlier and more rapid decline in response strength. Stronger and more durable extinction responding after partial reward was predicted and is in accord with "frustration" theories of extinction (Amsel, 1958; Spence, 1960).

Differential changes in running speed are also indicated by significant B x C interactions in individual analyses of the effects of response condition within each level of the reward-percentage factor (Table 2, p. 24). Among continuously-rewarded Ss, the decrement in running speed began earliest and progressed most rapidly in Group I; curves for Groups II and III are more similar in form, with Group III showing consistently superior performance and higher maximum strength (Figure 3, p. 25). When mean overall extinction performances of the three groups were compared by Duncan's multiple range test (see Edwards, 1960, pp. 136-140), using a protection level of 98 per cent, Group III ran significantly faster than Group II and Group I. Overall performance was stronger in Group II than in Group I, but the difference between means was not significant ($\alpha > .05$). The three response-condition curves for partially-rewarded Ss (Figure 3, p. 25) also are reliably different in form: the initial increase in response strength persists longer in Group III (50 trials) than in Group I (30 trials); and Ss in Group II, after exhibiting the largest decrement from the last day of acquisition to the first test day, showed progressively increasing response strength throughout 60 trials and only a slight decrease on the last test day. Comparisons between mean overall performances of the various groups (Duncan's test, protection level of 98 per cent) revealed that Group I and Group III ran

significantly faster than Group II. Although mean performance was stronger in Group I than in Group III, the difference between means was not significant ($\alpha > .05$).

Thus, the response-condition variable had the predicted effect upon overall extinction performance of Ss trained under continuous reward. The more effortful response sequence (Group I-c) was less resistant to extinction than the shorter, less effortful response to S^r (Group III-c); and extinction responding was stronger when the approach response was conditioned and extinguished under more (Group III-c) rather than less (Group II-c) similar stimulus conditions. The latter effect also occurred during extinction after partial reward--overall extinction performance of Ss both trained and tested in the goal box (Group III-p) was stronger than the performance of Ss trained on the alley-plus-goal box sequence and shifted to goal-box-only at the beginning of extinction (Group II-p). For partially-rewarded Ss, however, the effect upon extinction performance of a difference in effortfulness was contrary to the prediction that the more effortful response (Group I-p) would show less resistance to extinction. Lawrence and Festinger (1962, pp. 143-152) report a similar phenomenon and suggest that increased effort during acquisition and extinction intensifies the partial reward effect. In an experiment in which both percentage of reward and amount of effort were varied, resistance to extinction after partial reward was markedly greater under a high-effort than under a low-effort condition.

Examination of Figure 3 (p. 25) reveals that the curves do not resemble usual runway extinction functions. In most cases (e.g., Freides, 1957; Theios & Polson, 1962; Weinstock, 1954, 1958), response

strength begins to decrease after the first few nonrewarded trials and becomes progressively weaker throughout extinction. Some investigators, however, have observed that the characteristic decrease in response strength during extinction was preceded by a pronounced increase in vigor on early extinction trials. This period of enhanced response strength has been attributed to the effects of frustration produced by nonreward (see Brown, 1961, Ch. 6 for a discussion of relevant experiments and theoretical interpretations). Although running speeds increased before they decreased in all groups in the present experiment, this increase occurred only after an initial, rather severe decrement on the first test day. This marked initial decrease in response strength could be attributed to the unique extinction conditions of this experiment: as a consequence of the test procedure, generalization decrement occurred when the stimulus complex to which the approach response had been conditioned was altered by the addition of stimuli produced by the lever-pressing response in the test box. If the initial decrement can be explained in this way, then subsequent trends can be interpreted in terms of presumed motivational and associative properties of frustration.

Strength of new response reinforced by S^R . Results of a trend analysis (Edwards, 1960) of the lever-press data are summarized in Table 3 (p. 29). In this case, there was no significant interaction between reward percentage and response condition. Average speed of lever pressing under all three response conditions was significantly faster in the partial- than in the continuous-reward subgroups. This finding is similar to the results of several investigations (D'Amato et al., 1958; Klein, 1959; Saltzman, 1949) in which strength of a

Table 3

Summary Table: Analysis of Variance of Lever-Press Data

Source of Variation	Sum of Squares	d.f.	Mean Square	F	p
A: Reward percentage	181,955	1	181,955	5.71	.05
B: Response condition	801,285	2	400,643	12.57	.01
A x B: Rew. per. x resp. cond.	63,232	2	31,616	.99	
Error (a)	1,147,357	36	31,871		
C: Days	722,830	6	128,805	14.39	.01
A x C: Rew. per. x days	68,563	6	11,427	1.28	
B x C: Resp. cond. x days	349,414	12	29,118	3.25	.01
A x B x C: Rew. per. x resp. cond. x days	63,374	12	5,281	.59	
Error (b)	1,933,802	216	9,953		

secondarily reinforced response was relatively greater after partial than after continuous primary reward of the response to S^N during training. The response-condition effect also was significant; individual comparisons between means (Duncan's test, protection level of 98 per cent) revealed that speed of lever pressing after both partial and continuous reward was significantly faster in Group III than in Group II and Group I. Although Group II performance was stronger than Group I, the difference between means was not significant ($\alpha > .05$).

Figure 4 (p. 31) illustrates speed of lever pressing in the various groups as a function of test days. To facilitate comparisons between these trends and curves portraying extinction strength of the approach-to-reward response, curves are plotted separately for each response condition and for each reward percentage. A reinforcing effect of S^R upon the new lever-pressing response is evidenced by an increase in response strength in all groups. Speed of lever pressing at first became progressively faster as a function of trials (ranging from 20 in Group I-c to 50 in Group I-p), and then began to decrease. Mean response strength, however, was significantly ($p < .01$) greater on the last than on the first test day in all groups, indicating that S^R continued to exert a reinforcing effect upon the lever-pressing response over at least 70 trials.

The nonsignificant $A \times C$ interaction (Table 3, p. 29) shows that the trends of the daily means are not reliably different after partial- and continuous-reward training. In all groups, response strength on the first test day was approximately equal and the eventual decline occurred at about the same rate under both reward

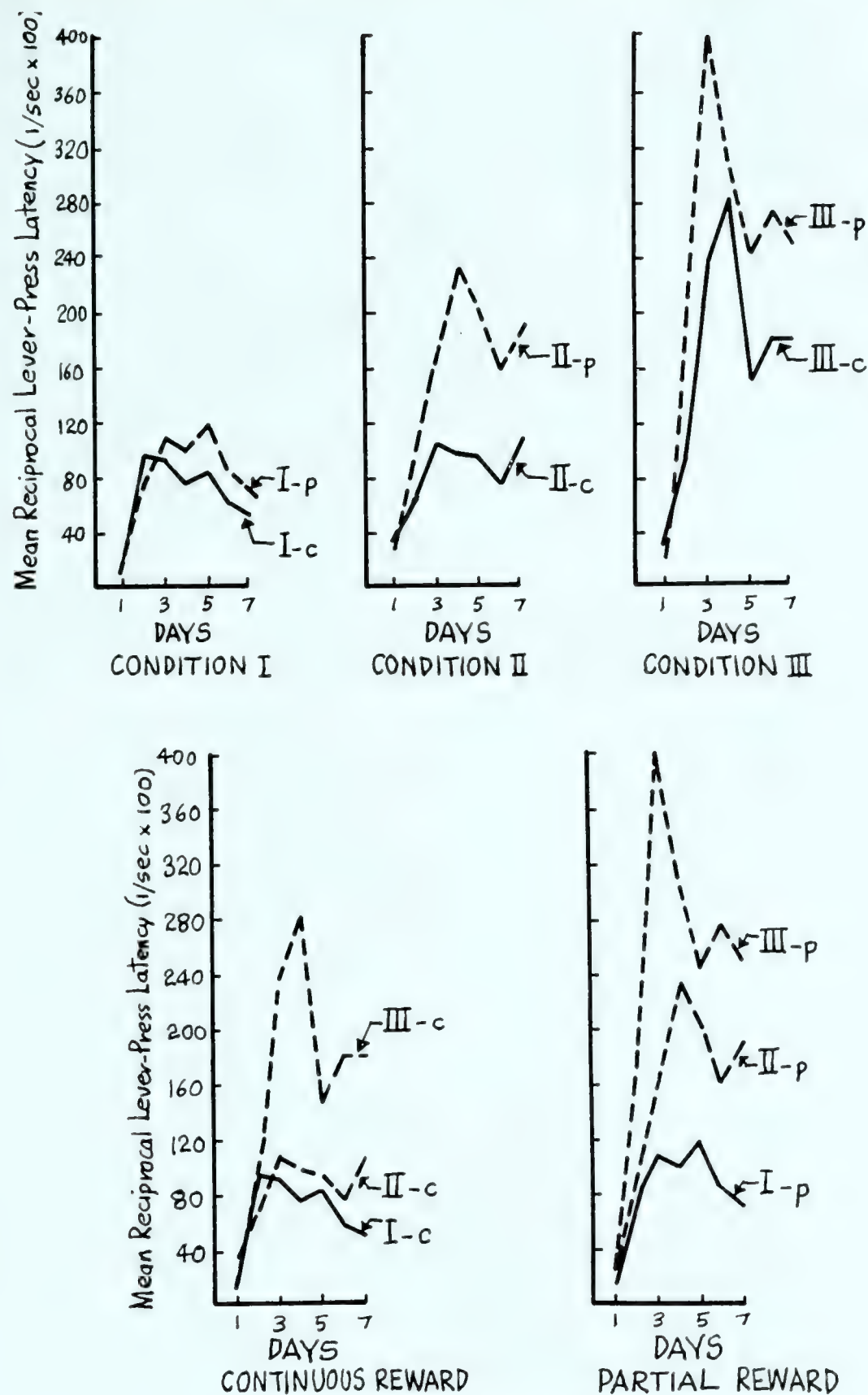


Figure 4. Speed of lever pressing as a function of test days.

The two curves for each response-condition group illustrate performances of continuous- and partial-reward subgroups; the three curves for each reward-percentage condition illustrate performances of the three response-condition groups. Each point represents mean performance of 7 Ss on 10 daily trials.

conditions; thus, the overall difference between continuous and partial performance apparently was related to maximum strength of S^R rather than to differential loss of reinforcing power. Taking into consideration the nonsignificance of the triple interaction, the significant B x C effect indicates that forms of the three response-condition curves are reliably different at both levels of the reward-percentage factor. Under both reward conditions, rising and falling slopes are markedly steeper in Group III than in the other two groups. Again, differential overall response strength ($III > II > I$) appears most directly related to maximum reinforcing power of S^R .

Relationship between secondary reinforcing power and resistance to extinction of the approach-to-reward response. In general, results of the trend analyses suggest some positive relationship between speed of lever pressing and strength of the response elicited by S^R . Overall strength of both responses was greater after partial than after continuous primary reward of the response to S^N during training. For continuously-rewarded \underline{S} s, the response-condition variable had similar effects upon overall lever-pressing speed and overall extinction strength of the approach response ($III > II > I$). Comparison of the curves in Figures 3 and 4 reveals that strengths of both responses tended to increase and decrease in a similar fashion as a function of test days.

As a direct measure of the relationship between secondary reinforcing power and extinction strength of the conditioned approach-to-reward response, the mean daily lever-pressing speed and the mean daily extinction score of each \underline{S} was paired and a coefficient

of correlation was computed. The positive correlation between the two performance measures was low and nonsignificant ($r = .03$, $df = 292$, $p > .10$ --one-tailed test of significance).

Discussion

The most noteworthy result of this experiment is the demonstrated effectiveness of a secondary reinforcer in a stimulus situation which had never been associated with primary reward. In all previous investigations in which a new response was strengthened by S^r , the reference response occurred in the presence of stimuli which had preceded primary reward during training. There would be reason to suspect that these stimuli might have played a crucial part in the secondary reinforcement process.

Acceptance of the hypothesis that conditioning of an instrumental response to S^N is necessary for the establishment of secondary rewards would not deny concurrent classical conditioning of fractional anticipatory responses to stimuli in the training situation. In fact, some learning theorists (Logan, 1960; Mower, 1960; Spence, 1960) suggest that strengthening of all instrumental behavior is dependent upon classical conditioning of anticipatory responses to various stimuli in an instrumental learning situation. Spence (1960), for example, hypothesizes a learned motivational factor (K) based upon internal stimulation (s_g) produced by a fractional anticipatory goal response (r_g) conditioned to external stimuli preceding primary reward, and suggests that reward variables affect instrumental performance by virtue of their effect upon strength of the r_g - s_g mechanism. Thus, Spence proposes an anticipatory response mechanism that strengthens instrumental behavior through producing an increase in general drive level. Other theorists (Mowrer, 1960; Osgood, 1953) believe that some stimuli in an instrumental learning situation become conditioned elicitors of anticipatory responses that

produce a learned motivational state, while other aspects of the situation acquire drive-reducing (reinforcing) properties.

Specifically, it is possible that "incidental" stimulus aspects of the training situation acquire the capacity to arouse a secondary drive which is reduced by occurrence of the stimulus event (S^N) immediately and consistently preceding primary reward, and that effectiveness of an S^r during testing may depend upon continuation of this motivational pattern. For example, in runway training procedures used to establish goal box stimulation as a secondary reinforcer (e.g., D'Amato et al., 1958; Klein, 1959; Saltzman, 1949), anticipatory responses may have been conditioned to cues arising from the alley preceding the goal box as well as to the designated S^N (distinctive goal box stimulation). In subsequent tests of secondary reinforcement effects, the goal box was removed from the end of the alley and replaced by the stem of either a T- or U-maze; the previously rewarded goal box was attached to one arm of the maze, a neutral box to the other arm; and S^r strength was measured in terms of "correct" choices (i.e., number of trials on which the previously rewarded goal box was chosen). The above studies found greater S^r strength after partial than after continuous primary reward and attributed differential effects upon the new (choice) response to the secondary reward values acquired by the distinctive goal box stimuli. It should be noted, however, that the new response occurred in the presence of alley cues. An extension of Mowrer's (1960) theory that a "secondary reinforcer is, basically, a stimulus which mediates a reduction in (secondary) drive" (p. 265) might suggest that secondary reward effects are dependent upon both motiva-

tional (drive-increasing) and reinforcing (drive-reducing) properties acquired by various stimuli in the training situation. When this suggestion is applied to the maze-learning secondary reinforcement procedure, it is possible that stimuli prior to the reference (choice) response aroused a learned motivational state which was reduced when a correct choice produced S^R (stimuli arising from the previously rewarded goal box). Similarly, it is possible that stimuli arising from the restraining compartment in the Keehn (1962) and Zimmerman (1959) investigations aroused a secondary drive which was reduced when the new lever-pressing response produced S^R --i.e., stimuli which had immediately preceded S^N during training.

Thus, the generality of the secondary reinforcement phenomenon is extended by this demonstration of S^R effectiveness when the stimuli in the test situation could not have acquired drive-inducing properties during training. This finding indicates that the reinforcing function of an S^R is not dependent upon reduction of secondary drive, unless one should wish to propose the arousal of a learned motivational state by stimuli which preceded introduction into the apparatus during training and testing--a not unreasonable suggestion, incidentally, when one considers such consistent events as pre-session removal from home cage, transportation to the experimental apparatus, and between-trial detention in the waiting cage. Nevertheless, strengthening of lever pressing in this experiment did provide a unique demonstration of the reinforcing effect of an S^R upon a new response in a new test situation.

It is important to note, however, that the S^R produced by each lever press in the distinctively different test box elicited

an instrumental response that carried S out of the new situation and into the presence of stimuli that had preceded primary reward during training. Zimmerman (1959) accounted for secondary reinforcement effects in his experiment in terms of a Guthrie contiguity theory, and attributed strengthening of lever pressing to the fact that the response to S^R immediately removed the animal from the restraining compartment and assured that the lever-pressing response was the last to occur in the presence of these stimuli. It is possible that these particular test circumstances were at least partly responsible for the extreme durability of secondary reinforcing power in the Zimmerman experiment. After partial primary reward and under a variable-ratio secondary reinforcement schedule, individual animals made thousands of lever-pressing responses during 10 to 14 90-min. sessions. In Keehn's (1962) investigation, in which the response to S^N was continuously rewarded during training and in which the S^R immediately following each lever press served a similar "removal" function, strength of a secondarily reinforced lever-pressing response increased as a function of trials one through seven and was then maintained at about the same level throughout 40 test trials.

Durability of a new, secondarily reinforced response in both of these experiments was much greater than in Skinner box studies (e.g., Bersh, 1951, Exp. 1; Estes, 1949, Exp. 1; Fox & King, 1961) where, according to a contiguity interpretation, the response elicited by S^R did not maintain strength of the new response by removing S from the presence of the stimuli associated with lever pressing. It is thus entirely possible that the "removal" function of S^R was

a necessary part of the secondary reinforcement process under the test conditions of the present experiment. In any case, it would not be legitimate to generalize from these results and conclude that an S^r would be effective in a new situation under other test circumstances.

There was no direct evidence to support the proposition that secondary reinforcing power is dependent upon extinction strength of the response elicited by S^r . When the curves in Figures 3 and 4 are compared, the lever-pressing and approach-response trends for each group appear roughly similar (in that they both increase and then decrease), but there is no point-for-point correspondence between variations in daily means. The direct measure of the purported relationship showed no significant correlation between individual daily speeds of lever pressing and speeds of the conditioned approach-to-reward response. This result is difficult to reconcile with the fact that the treatment variables did tend to have the same general effects upon the lever-pressing response and upon extinction of the response elicited by S^r . For both responses, maximum strength was greater and overall test performance was stronger after partial than after continuous reward during training; and, for continuously-rewarded S_s , the response-condition variable had the same effect upon overall strength of the two responses.

A theoretical interpretation based upon a classically conditioned anticipatory response mechanism would explain effects of the treatment variables upon both the lever-pressing and the approach response in terms of the effect of these variables upon extinction of a fractional anticipatory goal reaction. If one attributes acquired reinforcing

power to elicitation of an anticipatory response (Hull, 1952; Mowrer, 1960; Seward, 1956), then secondary reinforcing power would depend upon strength of the anticipatory response and would decrease as this response underwent extinction. According to several theorists who hypothesize an r_g - s_g mechanism (Logan, 1960; Spence, 1960), extinction of all instrumental behavior is related in exactly the same way to extinction strength of a conditioned anticipatory response. Thus, strength of the secondarily reinforced response and extinction strength of the approach-to-reward behavior should vary concomitantly as a function of the same learned interval reaction. Since there was no direct relationship between strengths of the two responses in the present experiment, effects of the treatment variables cannot be interpreted in terms of their influence upon extinction of an underlying anticipatory-response mechanism.

The fact that there appears to be no adequate theoretical explanation for this aspect of the results does not detract from the interest of these and other findings. Effects of the reward-percentage variable upon acquisition and extinction of the response to S^N indicated that, in general, partial reward had its characteristic influence upon instrumental response strength. The finding of earlier and stronger partial facilitation in the goal box than in the alley during acquisition, although in contrast with the results of previous research, would seem to be in accord with a "frustration" interpretation of partial-reward effects. The nature of the interaction between reward-percentage and response-condition variables suggests that the differential effect of partial vs. continuous reward upon resistance to extinction is greater when a long and more effortful, rather

than a short, less effortful response sequence is involved. Of greatest interest, perhaps, was the effect of the reward-percentage variable upon secondary reinforcing power under the unique conditions of this experiment. Generality of the partial-reward phenomenon is increased by the demonstration that an S^r associated with partial reward during training has a stronger reinforcing effect upon a new response established in a new stimulus situation. Although it is usually assumed that the influence of training reinforcement condition upon secondary reinforcing power is conveyed by its effect upon extinction of the response (either instrumental or internal) elicited by S^r , there apparently was in this case no direct correlation between strength of the secondarily reinforced response and of the conditioned approach-to-reward behavior.

Summary

This experiment was designed to determine the relationship between secondary reinforcing power, as indicated by a new-learning measure, and extinction strength of an instrumental approach-to-reward response elicited by S^R . Training procedures provided for the establishment of a clearly defined approach-to-reward response in the presence of S^N , and test conditions were arranged so that a new lever-pressing response in a distinctive test box "produced" S^R and permitted \underline{S} to make the conditioned approach response. To facilitate comparison between conditioned response strength and reinforcing power of S^R , two variables presumed to have differential effects upon extinction of the response elicited by S^R were manipulated. The test procedure also was designed to determine whether a secondary reinforcer would strengthen a new response when that response occurred in a stimulus situation which had never been associated with primary reward.

An approach-to-reward response sequence was conditioned to distinctive stimulus aspects of a straight-runway training apparatus: one response-condition group was trained on an alley and goal-box response sequence and was permitted to make both responses during testing; a second response-condition group was trained on an alley and goal-box response sequence but permitted to make only the goal-box response during testing; and a third group was both trained and tested on the goal-box response. For half of the \underline{S} s in each response-condition group, the approach response conditioned to S^N during training was followed by primary reward on 60 per cent of the trials; the remaining \underline{S} s received 100 per cent primary reward

during training. There were seven albino rats in each of the six groups called for by the design. Each S experienced 120 trials in the training apparatus, followed by 70 trials during the test phase of the experiment. At the beginning of testing, a distinctive test box was attached to the runway; each lever-pressing response in this box caused the exit door to open and allowed S to proceed through the designated section of the runway and approach the empty food cup.

Partial primary reward of the response to S^N had the customary effect upon acquisition strength of the alley response. After comparatively weaker performance on early trials, partially-rewarded Ss ran faster in the later stages of training. Partial facilitation tended to be greater and to occur earlier in the goal box than in the alley, a result which is not consistent with findings of other investigators but which apparently would be in accord with a "frustration" interpretation of partial-reward effects. The difference in terminal acquisition strength between partially- and continuously-rewarded Ss was not significant in any of the three response-condition groups. Extinction responding was stronger and more durable after partial than after continuous reward. The response-condition variable had the predicted effect upon extinction performance of continuously-rewarded Ss: (1) a more effortful response sequence was significantly less resistant to extinction than a less effortful response to S^I , and (2) performance was stronger when the approach response was conditioned and extinguished under more rather than less similar stimulus conditions. The latter effect also occurred during extinction after partial reward, but the influence of a difference in effort-

fulness was contrary to predictions. Strength of the secondarily reinforced lever-pressing response was significantly greater after partial than after continuous reward of the response to S^N during training, and the response-condition variable had the predicted effect upon lever-pressing performance of all S_s . Despite the similar effects of the treatment variables and similar day-to-day changes in strengths of both responses, there was no significant correlation between lever-pressing speed and extinction strength of the response elicited by S^R . There apparently is no adequate theoretical explanation for this result.

The demonstrated capacity of a secondary reinforcer to strengthen a new response in a new stimulus situation was the unique contribution of this experiment. When the new lever-pressing response in a distinctive test box was followed by instrumental behavior conditioned to stimuli that had preceded primary reward during training, lever pressing increased in strength and performance was maintained over 70 test trials.

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